RELAXATION BEHAVIOR OF ACRYLAMIDE-ALGINATE (AAM-ALG) WITH DIFFERENT MOLARITY OF CALCIUM CHLORIDE ($CaCl_2$)

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Introduction

Hydrogels are three-dimensional polymeric networks that include porous, hydrophilic, physical and chemical crosslinking [1-3]. Polyacrylamide (AAM) is one of the common materials that are used in variety of tissue engineering areas, but the pure AAM have extremely poor mechanical properties and biocompatibility [4–5]. Because of these shortcomings, the mechanical properties of AAM should be increased. One option is combining with other biomaterials such as alginate. Previous investigations have been indicated that the mechanical properties of pure AAM should be improved by synthesizing as double network with Alginate (ALG) [59–61]. We prepared AAM-ALG hydrogels containing various amount of crosslinker (BIS) and concentration of calcium chloride solution. Covalently crosslinked AAM and ionically crosslinked ALG contribute for extremely stretchable and tough properties on the hydrogels
The objective of this study is to conduct some experiments for determining of loading-unloading, creep, recovery and relaxation behavior through Polyacrylamide_Alginate (AAM-ALG) hydrogels that include different amount ionic and covalent crosslinker.

Materials and Methods

To understand the effect of crosslinking agents in the network we used different concentrations of $CaCl_2$ and N,N-methylenebisacrylamide (BIS). Hydrogels were synthesized by making an ALG and AAM solution with 1:8 weight ratio of alginate to acrylamide. The final concentration of ALG and AAM in the solution was 14% w. The ALG solution was heated in the oven at 121°C for one hour and cooled down at room temperature. It can be observed that the volume of the solution decreases after this step.
AAM and ALG solutions were mixed together. BIS of three different molar ratio 0,018 mol%, 0.028 mol% and 0,037mol% and tetramethylethylenediamine (TEMED) of 0.917 mol% relative to acrylamide monomer were added. After one hour the polymerization process is accomplished, the material is carefully removed from the mold and submerged into calcium chloride ($CaCl_2$) solution (0.05M, 0.1M and 0.3M) for alginate crosslinking. The uniaxial compression loading behavior of AAM-ALG was determined by using DMA Q800 (TA Instruments). Compression tests were carried out for different stress/strain levels.

Results and Discussion

A series of uniaxial compression loading tests were performed on three different AAM-ALG specimens that were prepared in 0.05, 0.1 and 0.3 M $CaCl_2$ solution at room temperature. The specimens are loaded up to 20% strain and hold at the same strain level for 5 minutes. Uniaxial stress-strain behaviors of AAM-ALG at room temperature on 0.05, 0.1 and 0.3 M $CaCl_2$ specimens are depicted in FIG. 1. The concentration of $CaCl_2$ solution dependency is clear; increasing molarity of $CaCl_2$ yields an increase in the stress level. Trends of these stress–strain curves are approximately the same. All specimens demonstrated hyperplastic behavior.

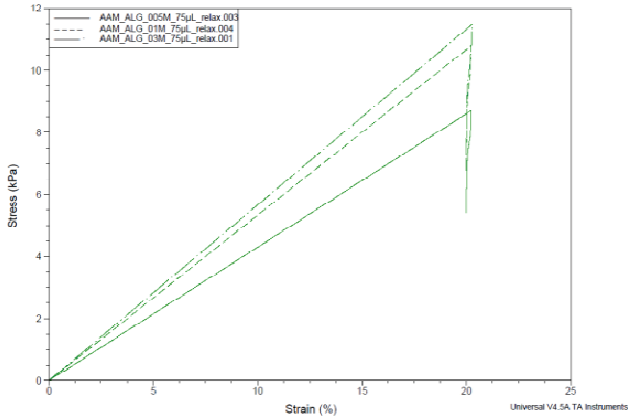

FIG. 1. Comparisons of loading behavior of AAM_ALG. Molarity of $CaCl_2$ solution are 0.05, 0.1, 0.3 M.

Relaxations at the strain levels of 20% were performed for 300 s to investigate the influences of concentration of $CaCl_2$ on the relaxation behavior. Stress versus time curves during relaxation tests at the strain levels of 20% are depicted in FIG. 2.

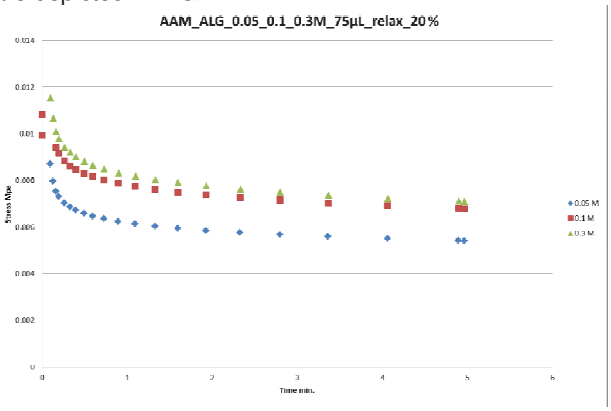

FIG. 2. Comparison of relaxation behavior of AAM-ALG at 20% strain level. Molarities of $CaCl_2$ solution are 0.05 M, 0.1, 0.3 M.

Conclusions

Observations are reported on AAM-ALG hydrogels in uniaxial compression loading tests with mixed program (loading a maximum strain 20% and hold for 300 s) at room temperatures. We used three different AAM-ALG that are 0.05, 0.1(75 µL BIS) and 0.3 M concentration of $CaCl_2$. Concentration of $CaCl_2$ solution dependency is clear; increasing molarity of $CaCl_2$ yields an increase in the stress level.

Acknowledgments

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